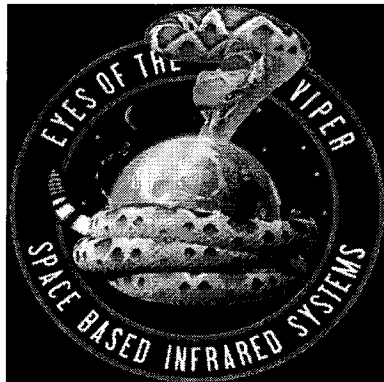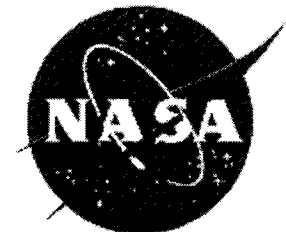# Spiral Model of Software Development at JPL

A presentation for the SBIRS Program Office

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Agenda

- Introduction
- JPL Project Architecture
- Spiral Model
- Risk Management
- Testing
- Configuration Management

- Collaborative Environment
- Measuring Progress
- ISO 9001 and Quality
- Voyager 1 & 2, Galileo & Deep Space Network
- Factors for Success

Introduction

- This is being presented as an overview of an area of interest and not a detailed tutorial.

- We hope to show how JPL's software development organization is a worthy partner and welcome collaborator for the SPO based on its quality product delivery system and directly related successful flight projects.

- JPL acknowledges the good work done in the by and for:
  - ☐ **SEI JPO in the area of the Spiral Model**
  - ☐ **USAF Software Technology Support Center**

- JPL recognizes the challenges of SBIRS LOW and shares the goals of the SPO.

Spiral Model Definition

"The spiral development model is a **risk**-driven **process model generator**. It is used to guide multi-stakeholder concurrent engineering of software-intensive systems. It has two main distinguishing features. One is a **cyclic** approach for incrementally growing a system's degree of definition and implementation while decreasing its degree of risk. The other is a set of **anchor point milestones** for ensuring stakeholder commitment to feasible and mutually satisfactory system solutions."

Dr. Barry W. Boehm

JPL Project Architecture

- JPL Project Architecture provides a solid structure for software development to transform the architecture into the correct implementation.

- The JPL Software Development process conforms to the JPL Project Architecture
  - ☐ **JPL Official Requirement document (JPL D-23713) describes the process**
  - ☐ **Fully compatible with the Spiral Development Model**

More Definitions

- Risk
  - ☐ **Risk are situations or possible events that can cause a project to fail to meet its goals.**

- Process model generator
  - ☐ **A process model answers two main questions.**
    - What should be done next?
    - For how long should it continue?

- Cyclic
  - ☐ **See the spiral model diagram!**

- Anchor point milestones
  - ☐ **Life Cycle Objectives (LCO)**
  - ☐ **Life Cycle Architecture (LCA)**
  - ☐ **Initial Operational Capability (IOC)**

Still More Definitions

- Life Cycle Objectives (LCO)
  - ☐ **The system boundary represented by the set of decisions on what _shall_ and _shall not_ be included in the system to be developed.**

- Life Cycle Architecture (LCA)
  - ☐ **Definitions of the system, components, interfaces, configurations and constraints.**

- Initial Operational Capability (IOC)
  - ☐ **The first time the users will see a functioning system.**

Documentation of LCO & LCA Milestones

- Operational Concept
- System Requirements
- System and Software Architecture
- Life-Cycle Plan
- Feasibility Rationale

Successful Spiral Characteristics

For *each* cycle…consideration for the main cycle elements

- ☐ Critical-stakeholder objectives and constraints
- ☐ Product and process alternatives
- ☐ Risk identification and resolution
- ☐ Stakeholder review
- ☐ Commitment to proceed

This is but one of the six "Spiral Invariants" described by Dr. Barry Boehm.

Spiral Model Diagram
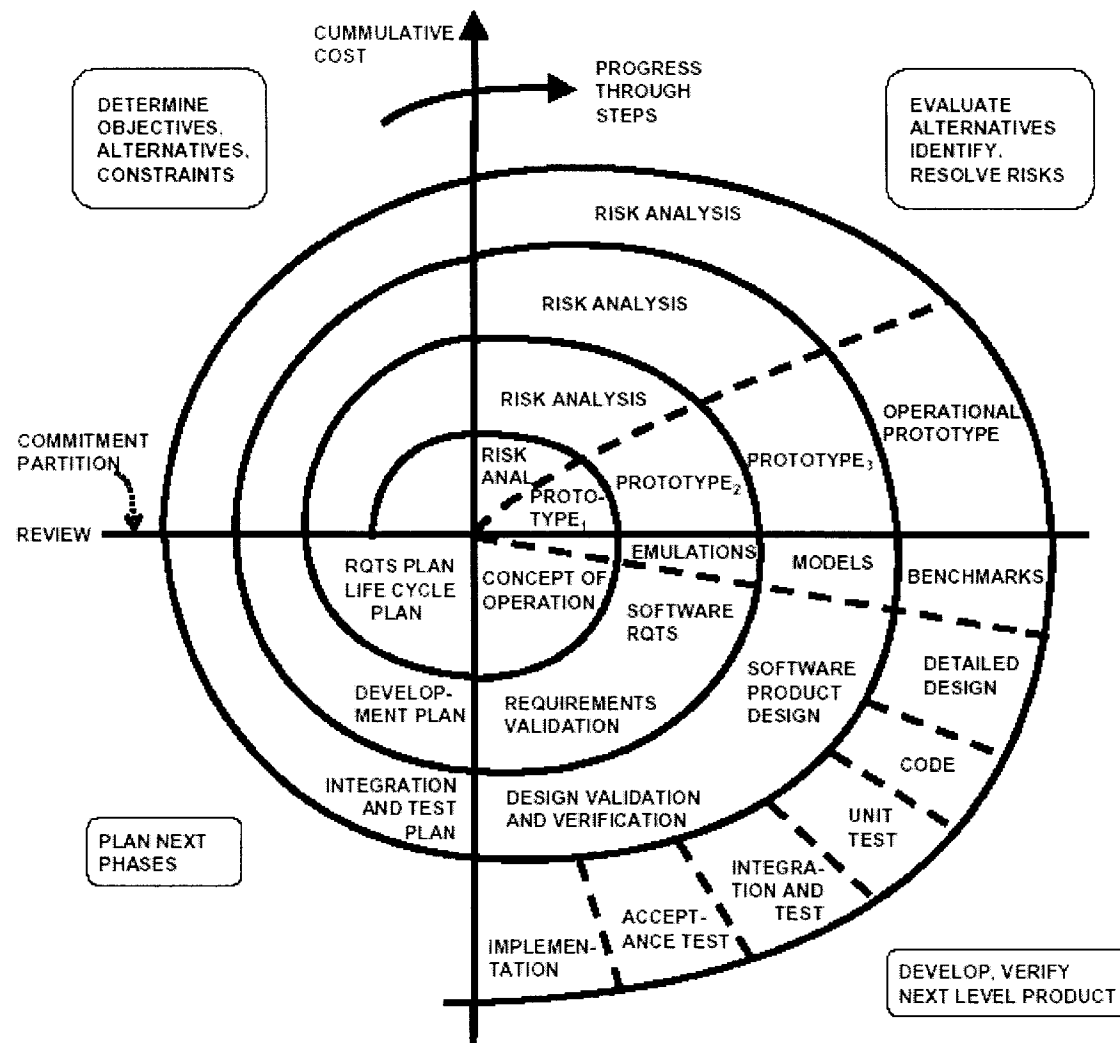
Risk Management

- SPO and JPL work together to create risk management plan and implement it
  - ☐ **JPL official Risk Management requirement document may be a good place to start**
  - ☐ **MDA has risk management plan**
  - ☐ **USAF STSC has additional resources**
  - ☐ **DoD Risk Management Studies**

- The Spiral Model can only work with continuous risk management

Testing

- Testing *is not* the last line of defense and it *is not* the only line of defense.

- Testing *is* an integrated element of the Spiral Model and is present at several stages.

- Spiral Model is designed so that the testing level of effort is driven by risk considerations.

- Project Test Plan collaboratively produced by SPO and JPL.

Configuration Management

- Configuration Management System (CMS), based on a project CM plan, is established in formulation phase of project and maintained until project is terminated.

- *All* software in CMS
  - □ **Prototype**
  - □ **Source**
  - □ **Utilities**
  - □ **Scripts**
  - □ **COTS**
  - □ **GOTS**

- *No* private copies

Collaborative Environment

- Focus on ease of use with measurable productivity gain
- Electronic libraries for all documentation
  - ☐ **Secure Web access for stakeholders**
- E-mail repository
  - ☐ **Contains the context for many decisions**
  - ☐ **Helps to facilitate knowledge capture**
- Secure instant messaging
  - ☐ **Builds communities of practice**
  - ☐ **Non-intrusive**
- Video-conferencing and shared applications as needed
- Co-location at JPL

Measuring Progress

- Earned Value Management (EVM)
  - ☐ **Common definition from**
    - NASA definition
    - DoD definition
- Common performance metrics tailored to the Spiral Model and the system
- Reports accessible to all

ISO 9001 and Quality

- JPL is the first federally funded research and development center to be certified to the ISO 9001-2000 standard.
  - **ISO 9000 is a series of standards that help organizations define and maintain a quality system (JPL calls this the Product Delivery System).**
    - It requires us to document how we do our work and then follow our own instructions.
- JPL's Quality Policy
  - **JPL will deliver products that meet or exceed customer expectations, while reducing (Spiral) cycle time and cost.**
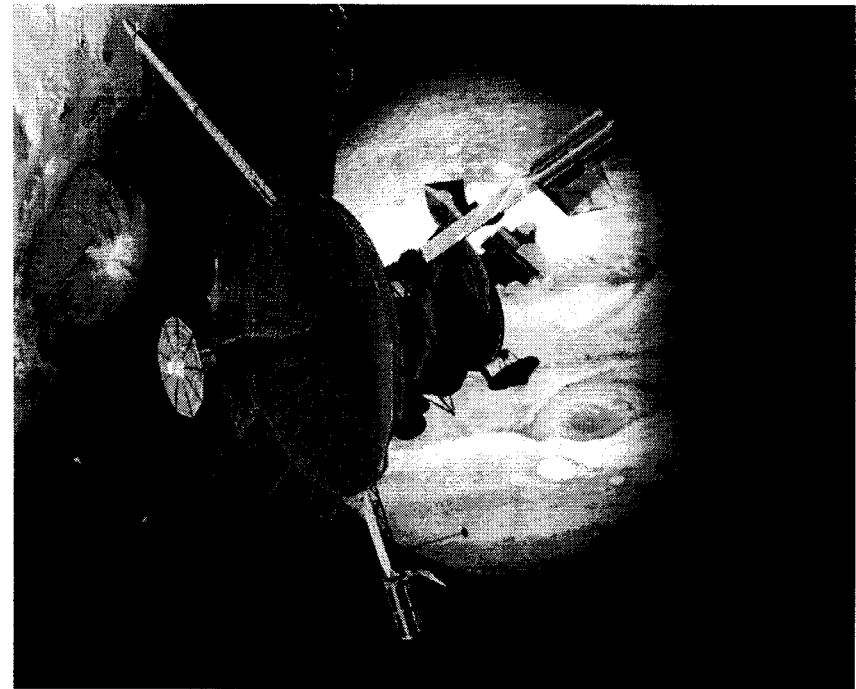
Voyager 1 & 2

- Launched in 1977 to take the "Grand Tour"

- Software upgrades (uploaded in flight) greatly extended the mission

- Planned to continue to operate and send back valuable data until at least the year 2020
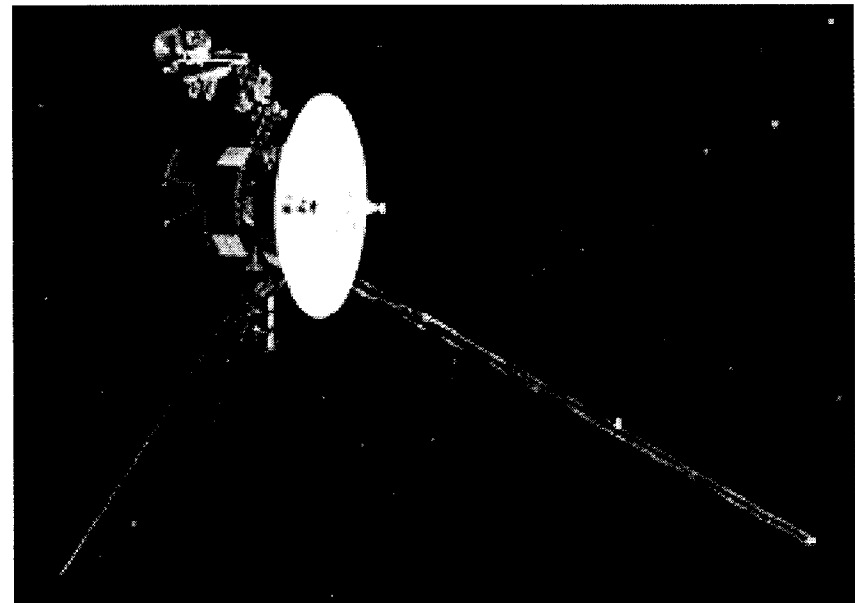
Galileo

- Launched in 1989
- Complex spacecraft (plus descent probe) with 6-year flight path
- Major booster change during design phase
- 16-foot hi-gain antenna failed to deploy but new flight and ground software developed (plus DSN upgrades) resulted in science data downlinked through low-gain antennas

Deep Space Network

- Established in 1958
- 3 Facilities
  - ☐ **Madrid**
  - ☐ **Goldstone**
  - ☐ **Canberra**
- 25 years of continuous service to Voyager 1 & 2
- Now serving 11 deep space missions
- History of successful h/w and s/w system upgrades
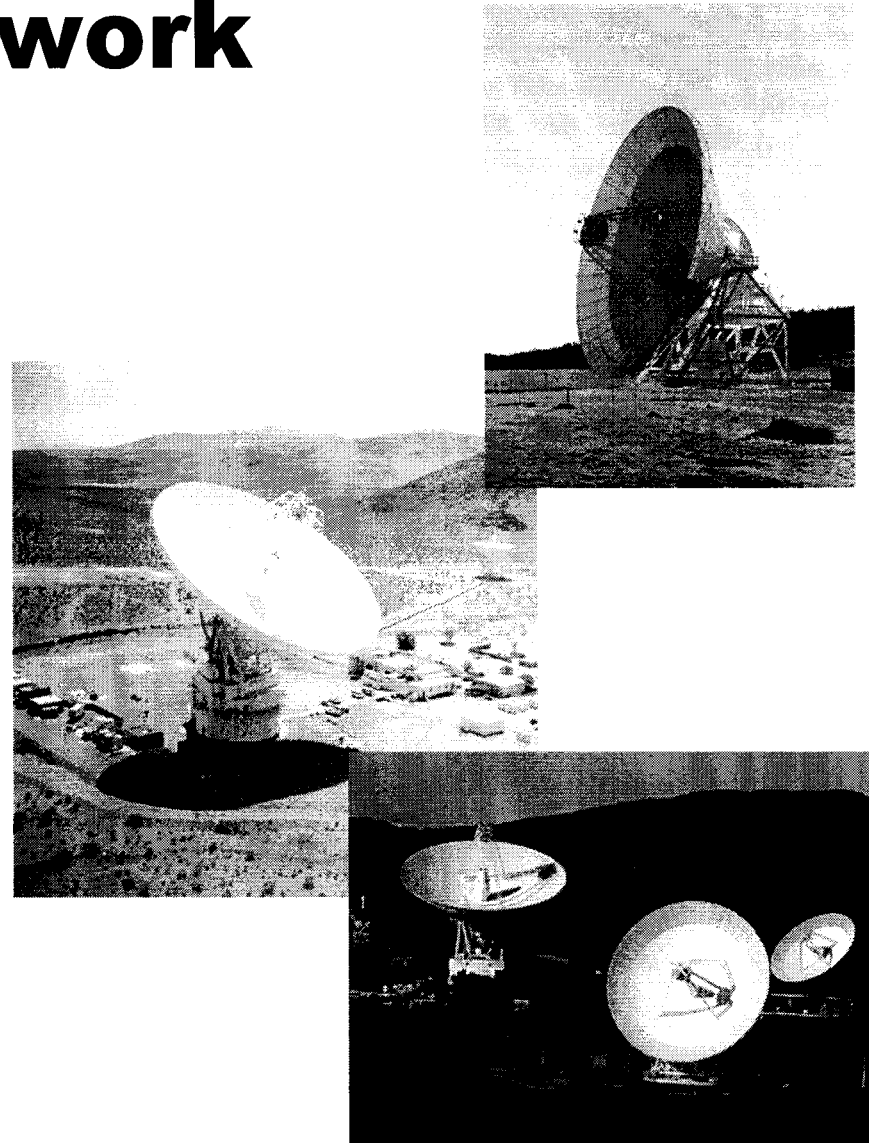
Factors for Success

- Support for the Spiral Model starts at the top
- It is a documented requirement of the project
  - ☐ **Project Implementation Plan**
  - ☐ **System Requirements**
  - ☐ **System & Software Architecture**
  - ☐ **Lifecycle Plan**
- Education and training on the Spiral Model is available to all and is part of the job
- No backsliding tolerated
  - ☐ **No Waterfall**
  - ☐ **No Code and Fix**